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*(Re)assembling Natures, Cultures and
(Nano)technologies in Public Engagement*

May 2015



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If only the preprint is available, you should cite this paper in the following way:

Felt, Ulrike, Schumann, Simone and Schwarz, Claudia (2015). '(Re)assembling Natures, Cultures and (Nano)technologies in Public Engagement'. To be published in *Science as Culture*. Available at <http://sts.univie.ac.at/publications>

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(Re)assembling Natures, Cultures and (Nano)technologies in Public Engagement

Felt, Ulrike, Schumann, Simone and Schwarz, Claudia G.

Practices of ordering are powerful means of giving structure to people's lives and providing a sense of control. The analysis of three episodes from discussion groups on nanotechnology in Austria shows that citizens evaluate new technologies with regard to how they intersect with, support, or disturb existing orders. The concept of discursive assemblages serves as a lens for recognizing the non-fixed character of the discursive process, while still allowing the analyst to identify how specific elements, such as conceptions of nature, culture and technology, are (re)assembled at particular moments. Each of the three episodes represents a specific way of creating and negotiating assemblages: the first case demonstrates how discussants collectively discuss a nature-technology hybrid (nano-bamboo socks) against the backdrop of a highly valued ideal of keeping 'the natural' and 'the technological' separate; the second episode exemplifies a clash of two assemblages as participants argued for or against the application of nanotechnology in food products; and the third example illustrates the process of collective experimentation with different assemblages to make sense of a highly futuristic nano chip for brain enhancement. Together the episodes demonstrate that participants in public engagement settings do not address nanotechnology as a simple question of choice between acceptance and rejection but rather engage in processes of care regarding how a society might develop when technological innovations such as nanotechnology threaten to blur existing boundaries and orders such as the distinction between nature and culture.

Keywords: emerging technologies, nanotechnology, public engagement, group discussions, assemblages, nature-culture-technology

Introduction

At the dawn of the 21st century, nanotechnology¹ entered the political stage both as a new and promising technoscientific field and as an expected driving force for the 'next industrial revolution' (National Science and Technology Council, 2000). Consequently,

it quickly became a central element of science and technology policies in Western nation states as well as the EU, leading to the establishment of major funding initiatives and policy action plans. The Austrian Nano Initiative, launched in 2004, and the Austrian Nanotechnology Action Plan (ANAP, 2010) exemplify these developments. The latter represents the output of a discussion process by a consortium of central actors in the field of Austrian nanotechnology governance, among them policy makers, scientists, and NGOs. The following quote from this policy document illustrates how the authors anticipated public reactions towards nanotechnology in the Austrian context:

Technophobia due to ignorance is a well-known phenomenon based on the fear of the unknown. [...] Dealing professionally with aspects of 'innovation resistance' in the light of former neo-technologies. It is necessary to avoid polarizing the debate, especially in the direction of 'nanotechnology is fundamentally dangerous.' [...] No secret should be made of the fact that 'Nano' is nothing new in innumerable (natural) fields [...]. (ANAP, 2010, 20f.)

Here, the Austrian public is characterised as technophobic due to an alleged knowledge deficit—an assessment that is presented as founded on former experiences with public opposition against new technologies (Felt, 2015). It is implied that the public might react in a similar way towards nanotechnology. Such generalised assumptions of innovation resistance, however, are 'a serious mischaracterization' (Felt and Wynne, 2007, 10), because they tend to disregard two important elements. First, science and technology are more often than not seamlessly integrated into everyday life without any questioning. Second, people do not necessarily employ a clear-cut logic of choice between acceptance and rejection, but rather tend to think in more open-ended terms about the generation and application of knowledge and innovation. Moreover, the Action Plan suggests that nanotechnology is 'nothing new' and hence 'natural' in order to influence public perception. If nanotechnology is categorised as 'natural,' according to the underlying logic, it would change from a potentially threatening innovation into something unproblematic. Such reasoning is not based on empirical evidence regarding whether public opinions are based on such modes of ordering (Law, 1994, Mol, 2010).

This leads us to ask a series of questions: how does 'the public' actually engage with and make sense of a new technoscientific field such as nanotechnology against the backdrop of previous experiences, existing values, and entrenched categorisations? Are lay people really responding to nanotechnology along the clear-cut line of acceptance and rejection, as policy documents seem to suggest? In this paper we approach these questions empirically by exploring four 4-hour discussion groups with Austrian citizens on nanotechnology. These group discussions took place at a time when debates on the governance² of emerging science and technology were undergoing a substantial shift towards integrating citizens' perspectives into decision-making about emerging technoscientific fields such as nanotechnology—at least on a rhetorical level (Irwin, 2006).

Nanotechnology was from its start perceived against the backdrop of a public backlash against agro-biotech in Europe, thus triggering numerous policy initiatives promoting so-called 'upstream' or early public engagement (Bowman and Hodge, 2007, Delgado et al., 2011, Wilsdon and Willis, 2004, Kearnes et al., 2006). These nano-related engagement projects have led to an extensive debate over the complexities of such processes. Among other aspects, the quote from the Action Plan and previous research illustrate that 'nature' plays a prominent role in scientific and policy discourses (Wickson et al., 2010, Bensaude-Vincent, 2004) as well as in public responses to nanotechnology (Burri, 2009). For instance, the European DEEPEN project has shown how citizens frequently articulate a 'messing with nature' narrative to express their 'concerns over nanotechnology's potential to disrupt long standing distinctions and boundaries [...] in the face of the possibility of redesigning nature to our own needs' (Davies et al., 2009, 19).

In addition, comparative research on public debates about biomedical technologies in different national contexts (Felt et al., 2010) suggests that citizens hold rather complex conceptualisations of technology and that these conceptualisations are always entangled with local cultural values, technopolitical habits, and societal structures. With regard to nanotechnology, such differences have also been traced in the dissimilar 'ways in which the category of nature was deployed' (Macnaghten and Givant, 2011, 216) in citizen debates in Great Britain and Brazil. Such comparative studies hint at the culturally contingent character of concepts such as nature and technology, yet they pay little attention to the contested character of such concepts within a single national context.

In this paper we develop discursive assemblages as a sensitizing concept to trace such context-specific entanglements of nature, culture and technology (NCT) in: (1) citizens' narratives about a local 'we' with its shared values and practices; in (2) references to well-entrenched actor constellations and their power structures; as well as in (3) the presence of broader sociotechnical imaginaries (Jasanoff and Kim, 2009) with regard to different nanotechnological application fields. We propose to explore lay people's ordering practices through discursive assemblages of NCT and their role in articulating and developing positions towards emerging technologies. In doing so, we refrain from presupposing fixed meanings of NCT, but view each of them as multiple and highly ambiguous concepts that only gain a specific meaning through the communicative purpose for which they are constructed. To further highlight this notion, we conceive assemblages as fluid and always in-the-making (Law, 1994), although temporarily stable at certain moments of negotiation.

As we discuss later, citizens' positions towards nanotechnological applications vary widely. For example, some welcome nano food as long as it enables the addition of tasteless 'vitamins and fatty acids'; others express scepticism, arguing that 'food is more than the sum of specific LEGO bricks'. Despite this variation, what is shared across the broad spectrum of positions is the effort to maintain or re-establish specific modes of ordering, after they have been challenged or disrupted by the appearance of nanotechnological innovations. People appear to be attached to the central modern idea 'that if our lives, our organizations, [...] or our societies, were 'properly ordered' then all would be well' (Law, 1994, 4f) because these orderings provide a sense of control. Instead of following the idea of a stable order, we focus our analytical attention on

the multiple and contradictory ordering or assembling processes at work as well as the material arrangements and tensions they produce (Mol, 2010).

The paper is structured as follows: it begins by introducing our understanding of the central analytical concept—discursive assemblages—and related theoretical debates. We then present our empirical material and several methodological considerations. The core of the paper is based on a fine-grained discourse analysis of three episodes taken from four 4-hour discussion groups. The episodes cover different application fields of nanotechnology and offer insights into specific NCT arrangements and diverse ways of (re)assembling. The results of this analysis lead us to conclude that the value of public consultation does not necessarily lie in understanding whether people approve of a new technology because they do not address nanotechnology as a straightforward question of choice. Rather, it is through creating, negotiating, and reworking NCT assemblages that people consider ‘the contextuality, the complexity and the continuous development of science-society issues’ (Felt et al., 2013, 4) and thus engage in what, similar to Mol (2008), we conceptualise as processes of care for a society so deeply entangled with technological innovations.

Discursive and ethno-epistemic assemblages

Analytically, we approach discussion groups as settings in which participants draw on a variety of elements to make sense of nanotechnology. As discourse analytic work has shown, opinions and attitudes should not be understood as stable and bound to the individual but rather as generated and shaped in argumentation and debate (Billig, 1987, Myers, 2004). To avoid a static and individualistic conception, we examine *discursive assemblages* in the discussion groups. These assemblages should not be conceived as pre-existing mental constructs but as a heterogeneous patchwork of fluid and situated configurations drawn together to achieve a specific effect in interaction.

Despite their fluidity, assemblages also have to respond to requirements of consistency and coherency (Deleuze and Guattari, 1988). In the case of discursive assemblages, coherency refers to the internal order and organisation (internal relations) in an assemblage, whereas the idea of consistency alludes to both the integration of the assemblage into the self-presentation of the speaker and the broader cultural context (external relations). However, because consistency is subject to change in the ongoing flow of discourse, it is analytically more fruitful to explore contradiction rather than consistency (Myers, 2004). In fact, individuals frequently express contradictory positions in discussions without attempting to reconcile them, which again can be taken as empirical evidence against socio-psychological models of consistent opinions or attitudes residing in people’s minds.

In the discursive assemblages we aim to identify in the material, all elements of an assemblage are related to one another; however, the form of these relations may change. Additionally, assemblages may support or oppose other assemblages. The most important point is that an assemblage represents a specific version of reality—and this reality can be either socio-culturally shared or contested. This conceptualisation, in turn, makes it necessary to arrange the elements of an assemblage such that they appear as an acceptable claim about reality. Thus, whenever discursive elements are ordered such that they appear as a (temporally stabilised) coherent and consistent

claim, we are able to identify an assemblage in discourse. Such assemblages may contain language that refers to (1) human actors such as scientists, policy makers, industrialists, or citizens; (2) non-human actors such as material artefacts or technologies; (3) broader distinctive concepts such as nature and culture; (4) legal frameworks and institutions of control; and (5) experiential resources, practices, and sets of relations.

Our conception of assemblages is further influenced by Irwin and Michael's (2003, 146) notion of 'ethno-epistemic assemblages', which the authors use as a heuristic tool to 'focus on, and excavate, the empirical complexity and heterogeneity of relations between lay publics, scientific institutions and forms of governance'. Integrating the concept of ethno-epistemic assemblages sensitises us towards the importance of acknowledging different types of knowledge, their situated and culturally rooted character, as well as the importance of knowledge relations within such assemblages. This integration enables the accommodation of several blurrings between science and society, citizens and experts, expert and lay knowledge, as well as between 'the global' and 'the local'. As Irwin and Michael (2003, 112) emphasise, one can 'see many "natures" and many "socials" being co-constructed by many co-actors who are themselves co-constructed as both lay and expert.'

The concept of assemblage therefore draws our attention to the co-construction of assemblages and to the ways in which assemblages evolve, hold together, and function, also in relation to other assemblages. Indeed, the concept points to the fact that moments of temporary stabilisation are analytically relevant for elucidating power relations as specific attributions of agency and forms of governance. Constructing a problem as natural, technical, or socio-cultural in this context makes a difference in terms of who should or could act and take responsibility. Hence, what is taken for granted in assemblages and what is regarded as subject for negotiation contribute to people's capacities and radius of action.

Entanglement and separation

As outlined above, we aim at identifying assemblages in the material in which people relate to NCT—an interest that is tied to a long tradition of questioning these categories in STS. Latour (1993) has extensively reflected on the consequences of the modern paradox of thinking of nature as an entity clearly delineated and distinguishable from culture and has highlighted their fluid, blurred, and interwoven character. According to Latour, unnoticed acts of translation, notably by technologies, contribute to the proliferation of nature/culture or non-human/human hybrids, which, in turn, call this clear distinction into question. Similarly, notions such as cyborgs (Haraway, 1991) or monsters (Law, 1991) highlight that we live in a world in which technoscientific developments transgress established distinctions and therefore have the power to shake existing orders and power relations.

Despite the proliferation of hybrids, traditional orders such as the distinctions between nature and culture/technology are by no means dissolved but remain powerful political and social categories on which people rely in their everyday lives. The concepts of nature, culture and technology are concepts of difference (Neill et al., 2008), which means that they acquire their meaning precisely by being distinguished from each other. In discourse, these concepts are often attached to objects and phenomena.

For instance, nature is used to refer to landscapes, animals or bodies, whereas technology is applied to denote material artefacts or human-made processes, and the word culture is used synonymously with rituals, myths, and practices.

In their adjective form, the concepts address (intrinsic) properties but can also be thought of as processes, i.e., in terms of transforming an object from a natural into a technological state of existence (technologisation) or of purifying the natural from techno-cultural pollution to (re)establish an ideal state of the social order (Douglas, 1966). Thus, when investigating lay citizens' discussions of emerging technosciences, we need to explore both the appearance of hybrids and the processes of drawing or reinforcing lines between 'the cultural', 'the technological', and 'the natural'. In this sense, we ask how versions of NCT are mutually constituted or transformed with each other, how their boundaries are blurred or entangled but also demarcated, and made robust. Such a process-oriented understanding draws our analytical attention towards the specific practices (such as striving for purity), when categories, conceptualised as distinct and opposing, move closer together and become intermingled.

Shared Knowledges in Technopolitical Cultures

As we empirically explore how conceptions of NCT are employed and developed in talk-in-interaction, we also look at our material through the analytical lens of what these discursive assemblages tell us about culture. The concept of ethno-epistemic assemblages is relevant because 'epistemic' highlights the fact that collectively shared assemblages define what is considered as real and true (Michael, 2006), whereas 'ethno' hints at the situated character of knowledge and how this plays out in the assemblages we study (see also Haraway, 1991). Assembling is never a placeless activity; it has to be understood in its cultural context, i.e., in a specific technopolitical culture (Felt et al., 2010) with well-entrenched traditions of relating society to specific technologies (Felt, 2015). This conception suggests that citizens do not only employ their individual ways of knowing but also refer to shared ways of assessing epistemic claims and technological arrangements. Concerning the latter, we draw on Jasanoff's concept of 'civic epistemologies' (2005, 255), which highlights that 'modern technoscientific cultures have developed [distinct] tacit knowledge-ways through which they assess the rationality and robustness of claims that seek to order their lives'.

However, in this article, we want to move beyond Jasanoff's focus on political elites and institutional actors and how they establish their ways of knowing in a specific cultural context. We include non-institutional forms of knowledge and citizens' ways of knowing—what has also been referred to as 'citizens' epistemologies' (Felt et al., 2010). Therefore, both personal experiences and the 'thought collectives' (Fleck, 1979 [1935]) that participants are part of in their everyday-lives, as well as how they perceive the predominant civic epistemologies in their specific national context, must be taken into account. We thus believe that 'a promising way to study what we call "culture" consists of detecting what is literally and figuratively cultivated in interactants' discussions and conducts' (Cooren, 2010, 10). From this perspective, culture refers to what (e.g., concepts of nature) is taken implicitly for granted in its existence or absence. Austrian technopolitical culture hence might manifest itself in the material, for instance, as an absence of calls for public participation (Felt et al., 2008) or in undisputed articula-

tions of a national identity of being very close to nature (Felt, 2015). However, when discussing the importance of technopolitical cultures, we must be cautious not to overemphasise their homogeneity and acknowledge that national technopolitical identity represents just one among other identities people may temporarily assume. Here, the concept of assemblage again assists in keeping the analytic gaze open towards potentially competing assemblages as well as towards the fluidity and context-dependent nature of identity constructs.

Material and method of analysis

To understand how assemblages are co-constructed interactively in a discussion setting, we draw on transcripts of four discussion groups held in Vienna in December 2009 and January 2010, each lasting four hours.³ In each of the four groups, six different participants discussed nanotechnology with regard to a specific application area (i.e., food, everyday products, medicine, information and communication technologies). The research team developed a methodological tool called IMAGINE (Felt et al., 2014) to facilitate discussion about nanotechnology, which was at that point an unfamiliar technology without any broader public discussion in Austria. The purpose of IMAGINE was to provide participants with textual resources printed on cards and to arrange the discussion in four stages. Initially, each participant received a set of cards consisting of four different types: story cards, application cards, issue cards, and future cards. Each stack of cards corresponded to a phase in the setting's choreography.

At each stage, participants were invited to choose cards they personally perceived to be most relevant and to discuss their choices afterwards. The content of the cards was based on a previous analysis of main public positions, issues, and expectations about nano in the European and Austrian context, drawn from stakeholder interviews with scientists and policy makers as well as media articles, the PlayDecide⁴ card game, and various nano-related documents. We observed that participants dealt very flexibly with the cards, arranged and interpreted their content based on their relevance, as well as discussed and developed them further collectively in the debate. In contrast to other public engagement projects on nano, which often require people to come to a definitive assessment or consensus at the end of a workshop, our interest was more in the very processes of discussion.

In terms of methodology, the analysis in this article is inspired by discourse analytic studies that focus on how lay people come to grasp technoscientific innovations as well as on the dynamic and interactive processes in group settings (Davies, 2011, Horlick-Jones et al., 2007, Felt et al., 2009). Such a discourse analytic perspective addresses the 'problem of analysing stability in fluidity' (Horst, 2007, 154). In talk, specific assemblages emerge and are momentarily stabilised, but, as discourse is always fluid, they can never be understood as truly solid because at any moment an assemblage can be rearranged or contested. Hence, the aim of our analysis is not to identify assemblages, but to capture the fluidity of discursive processes by analysing how assemblages change, evolve, and encounter different assemblages, and are negotiated in interaction. However, it should be made clear that we as analysts also contribute to the stabilisation of assemblages when we stop at certain points to generate an inter-

pretation. The data we explore is messy in the sense that there is no linear narrative, as people interrupt each other or lose their thread of thought, partly coming back later. We therefore want to acknowledge our own ordering work when drawing together seemingly chaotic or spread utterances and narrating them as more coherent episodes to enhance the readability of this paper.

Assemblages in lay talk about nanotechnologies

While analysing the transcripts of the discussion groups, we noticed that the discussants engaged in quite complex discursive assembling practices of NCT when confronted with nanotechnological applications. To do justice to these practices, we analysed three longer episodes in detail. By including multiple original utterances and interactions, we try to be as transparent as possible concerning our analytical process; however, we acknowledge that our analysis sometimes goes beyond the reproduced quotes because otherwise it would not have been possible to accommodate our argument within the given scope. Through this approach, we hope simultaneously to cover a number of topics: the variety and breadth of NCT assemblages; how they are negotiated and are associated with specific types of agency; and the ways a nationally shared technocultural history as well as personal experiences matter when participants make sense of new technologies. Moreover, assembling practices in the episodes differ quite substantially concerning the ways in which they constitute oppositions. The case about nano food illustrates a conflict between two participants; the debate about nano socks emerged with collective oppositions against an imagined outside (e.g., industry, lobbies); whereas the nano brain implants evoked a continual experimentation with assemblages and hence neither a clear inside- or outside-oriented opposition.

Constructing a purified assemblage – An episode about nano-bamboo socks

In the group on consumer products, a rather long debate surrounding bamboo socks containing nano-charcoal fibres—introduced in one of the application cards (see *Application Card #1*)—became interesting territory for observing the emergence of a specific assemblage. It began with the following exchange:

Denise⁵: For instance, socks, I actually have these bamboo socks [laughs] that are mentioned on the card. And I didn't know that they include nanotechnology [spoken with laughter].

Ernst: Yes, right, that it's with nano and it's bamboo.

Denise: Yes, I also thought that sounds so organic.

Mod: You have imagined the small panda that nibbles on the bamboo.

[laughter, clutter of voices][...]

Denise: I thought that they are particularly environmentally friendly now and that this is a super natural fibre. That was how I interpreted bamboo fibre, right?

Barbara: Yes, I also understood it that way. (859-78)

Application Card #1

clothing and textiles



Clothing and home textiles become multi-functional with nanotechnology, e.g. they get anti-bacterial, UV-resistant, dirt-, water-, and wind-repellent, but also softer, lighter, more breath-able as well as more tear- and abrasion-resistant. Socks with bamboo charcoal nanoparticles can prevent foot odour. It is hoped that it will be possible in the future to produce smart clothing by combining nanotechnology with fabrics, which for instance could measure bodily functions

When Denise, a 30-year-old lawyer, realises that the bamboo socks she uses herself might contain nanoparticles, the group starts to ponder over the entanglement of nanotechnology with organic/natural materials (bamboo). What irritates them is that nano manages to enter their lives in the guise of 'the natural' without them noticing. They clearly associate bamboo with natural fibres, which triggers reflections about how nature—in this case, the environment—should be protected. Additionally, bamboo-eating pandas engender a very positive and harmonic vision of nature. At the same time, nanoparticles are viewed as an intrusion, representing the artificial and unnatural. The participants thus co-construct the nano-bamboo socks as a disturbing nature-technology hybrid.

The socks also become a lens through which the discussants look into the complex, often invisible, networks of actors, materialities, and cultural values embedded in the production and consumption of such goods. However, the socks do not simply irritate participants because they entangle two semantically distant areas but also because the integration of nanoparticles is perceived as transforming a safe (i.e. 'natural') product into a potentially dangerous one.

Denise: And I ask myself then, I wore these socks for hiking, because they don't stink, and then I got a blister. Well, I was of course wearing these socks on the blister. Now [laughs] [...] I think, through that blister some nanoparticles could have entered my body. (880-3; 915)

Here, Denise expresses her unease about potentially harmful nanoparticles intruding her body, implicitly also questioning—which becomes more explicit in further exchanges that we could not include in this paper—whether the producers would have considered such aspects when thinking about the safety of their products. The nano-bamboo socks reappear later in a sequence of fast turn taking, which indicates that the group is working on something of particular relevance. The distinction between natural and technologically altered materials becomes the centre of debate at this point:

Barbara: Well, you have to admit that the natural is actually already more chemical than the chemical through the treatment it gets.

Claus: Of course.

Barbara: Yes, and it's hardly existing actually. One can just hope that somewhere organic, untreated cotton is sold. But that is only a small proportion in fact. Black silk underwear, for instance, causes most allergies, because black is the worst and most poisonous colour. Then the chemical stuff is almost better. [...] Or cheap and modified cotton. You have to wash a t-shirt in any case, because it smells of chemicals.

Franka: Well, it's all a question of product range. There aren't any alternatives anymore, are there? You cannot find a cotton scarf anymore.

Barbara: Well, you can find it maybe, but if it's treated then it doesn't matter that it's cotton or something else. It's full of chemicals, solely because of how it's grown. There's no point in buying it then. (1157-91)

In this sequence, chemically transformed 'natural' materials are portrayed as blurring the distinction between natural and technological/artificial materials. The discussants criticise the mixing of the technological and the natural in such hybrids. Hybrid materials are viewed as neither natural nor technological but come to represent a third category deemed even worse than purely chemical/technological materials. As a result, treated natural materials are dispelled from the category of natural materials and reclassified as chemical, technological, or artificial. Thus, the category 'natural' is purified, with non-treated organic/natural materials becoming the last remaining but exceedingly narrow refuge of the natural. This purification move allows for nature to be reclaimed as a category that guides buying decisions—it stabilises existing orders and distinctions to which people try to orient (Douglas, 1966).

Although redrawing the boundary of 'the natural' appears to be a solution on a more abstract level, participants show awareness that industrial processing (chemical treatment, the adding of nanoparticles) is continuously pushing into the domain of 'the natural'. Consumers, hence, are perceived as rather helpless in that they largely depend on what the market offers. This dependency becomes even more apparent in further discussion when the issue of labelling as a culturally established way of rendering production processes more transparent emerges. Consumers must somehow rely on labels—a widespread practice in the Austrian context—to inform them about the essence of products. However, Barbara challenges the trust that consumers put into organic labels by claiming that these products are often a scam because they do not deliver what the label promises, an accusation she supports by referring to a radio report she recently heard: 'I cannot trace every product I buy into its country of origin and investigate how it's produced. On what can I still rely?' (1204-6). This situation poses a dilemma because production processes have become global and it is difficult to verify whether organic labelling is rightfully applied. Denise agrees and relates this sentiment to her experience with the nano-bamboo socks:

Denise: These bamboo fibres with nanotechnology, I wouldn't have noticed this in 10.000 years. Well, I mean, I try to buy natural fibres. And pay attention to it. However, if I don't know that it's somehow modified or that nanotechnology is in it, then I can't make any decision. (1210-3)

Both participants complain that their agency as responsible consumers is being undermined. Whereas Denise criticises the absence of nano-labelling, Barbara articulates a challenge for consumers in two respects: (1) having to find natural materials; and (2) sensing whether labelling is applied correctly, which is problematic because consumers do not possess any immediate (sensory) means to detect boundary transgressions. Hence, consumers find themselves dependent on labelling as an institutionalised way of making relevant distinctions visible. In reaction to the lack of trust in existing labels, the participants perform another move of purification to expel the 'false organic fibres' from the 'natural' category. The natural as a relevant category can only be sustained with the help of trustworthy, independent actors such as 'lawmakers' (Claus, 1215) and 'certifying bodies' (Ernst, 1282), who devise nano-labels and test materials for toxicity. Consumers are thus depicted as being in need of powerful political allies, such as the state or regulatory agencies, who can restrict industry's capacity for deception.

The episode of the nano-bamboo socks illustrates how participants collectively explore the hybrid character of a—at first sight—mundane object and co-construct a specific assemblage comprising a set of selected actors, agencies, and interdependencies. Although contemporary consumer culture is permeated with nature-technology hybrids such as the nano-bamboo socks, consumers try to maintain the distinction between the natural and artificial as a relevant framework of orientation. The participants perform various purifying moves to reclaim the natural and argue for the creation of ecological niches for pure natural products in the market system. However, this assemblage, in which the natural is to be protected through controlled labelling, is perceived as rather fragile because the textile industry is imagined as a non-trustworthy actor, and it remains unclear whether political agents will be able and willing to exert control.

A clash of assemblages – An episode of nano food

The second episode is taken from the nano food discussion group. It revolves around a highly controversial and emotional interaction between two participants, sparked by the more general issue of what constitutes appropriate nutrition for children. Rosa, an

Application Card #2

Nanocapsules as transporter for healthy nutrients



Nutritional supplements such as vitamins or pharmaceuticals can be packed into minuscule capsules and thus added to all kinds of foods.

In Australia certain brands of bread are on the market, enriched with fish oil good for your heart. The omega 3 fatty acids are encapsulated, which avoids the unpleasant smell and tasting fishy. These additives unfold, once inside the body, their full effects.

elderly woman and former kindergarten teacher, argues that children would eat healthier if their favourite food (noodles) were enriched with nano-encapsulated vitamins. In her opinion, nano offers an opportunity to resolve food-related problems she experienced in her work context without intervening in individual/collective preferences and societal arrangements. This idea is challenged by Robert, a middle-aged biologist and hobby organic beekeeper, who argues that the absence of vitamins in nutrition cannot be supplemented artificially and suggests solving the problem of children's unhealthy nutrition at a socio-cultural level. This episode bears analytic attention because it reveals a clash of two very distinct assemblages and not, as in the case of the nano socks, a more

collectively elaborated assemblage. The discussion begins with Rosa explaining her choice of the application card (see *Application Card #2*):

Rosa: I have chosen card number 2 and it says that there is the possibility to enrich food with vitamins and fatty acids. And yes, I think, if it's true what it says, that it's also tasteless, then I'd like it; because, as I said at the beginning, I was a kindergarten teacher and the children, they have actually just the food they get for lunch, and yes, it'd be quite good if that would be richer in vitamins, because there is not so much salad or vegetables or fruits [...]. In the evening when the children come home, I know that from my experience, what the children told me, that they mostly just get rice or semolina pudding [...Yet] it's impossible that the kindergarten adds many vegetables or fruits. The parents would see that as too expensive. (235-53)

In this quote, Rosa outlines how a dilemma emerges in an institution that accommodates the next generation: a kindergarten. By drawing upon her experience, she identifies two main problems with regard to food: First, children are inadequately nourished at home; and second, parents are not ready to spend more money on healthier food at kindergarten. The responsibility for providing a healthy lunch is thus shifted to the kindergarten, which cannot fulfil such expectations due to financial restrictions. Rosa therefore perceives functional food as a technological fix that would compensate for the shortage of vitamins in children's nutrition or, more generally, as a remedy for a socio-cultural problem. This solution is both 'easy', a word she uses herself in this context, and invisible for the children—it thus would not disturb existing orders. From what we know based on Rosa's other statements, she considers nature (here, in the form of food) to be in an imperfect state that humans can readily improve upon. To her, technology functions as a means to counteract both natural and socio-cultural shortcomings. This understanding is further tied to a mechanistic concept of the human body and to an understanding of food being a sum of discrete nutritional elements (e.g., vitamins).

The following quote indicates that Robert holds an opposing view of how nutrition works and that he rejects the vision of nanotechnology enriching food with vitamins.

Robert: Well, [...] I am actually no expert in the food area, but as far as I understand, food is more than the sum of specific LEGO bricks that you can replace arbitrarily. And I have big doubts that you can artificially add vitamins through nanotechnology, vitamins that are lacking in a not well-balanced diet. (257-261)

In contrast to Rosa, Robert sees nutrition as a complex, interrelated system. He challenges the vision embedded in nanotechnology that nutrition—which he perceives as natural—is composed of building blocks that nanoscientists can manipulate at will (López, 2004). In his view, knowledge about nutrition is experience-based and more implicit and thus not necessarily tied to scientific expertise. In the following exchange,

Robert presents himself as competent enough to challenge the vision of nutrition represented on the card.

Rosa: I don't know myself, but it says it here, doesn't it?

Robert: Well, I believe nutrition is just not working like that. It's somewhat presented like that here [...]. I believe it's...

Rosa: I have no idea if it works like that or not, but... (263-8)

Here, Rosa underlines that she does not know whether or not the text on the card is true but takes it as given. She is inclined to trust expert statements explaining what the body needs. This trust in and acceptance of scientific expertise represents a specific type of lay-expert relationship, which is highly culturally anchored and might also be interpreted in generational terms. As a follow up to this short exchange, Robert makes yet another move and embeds nutritional behaviour in a much broader context:

Robert: Basically, it's all about a relatively unnatural way of living. For example, if you sit for ten hours in front of your computer and don't move anymore, driving with the car to the computer, sitting ten hours and then back, then it's obvious that you need two hours on the exercise machine afterwards, to survive at all. In a balanced lifestyle, with more exercising, also in your daily routine, this would not be necessary. (273-9)

An unnatural way of life is here problematised and equated with a lack of physical exercise. The 'exercise machine' represents a technological answer to a problem that is, in Robert's eyes, rooted in culture. Unlike Rosa, Robert challenges the idea of a technological fix by stressing that through a balanced lifestyle such undesired developments can be avoided. In his account, technology is implicitly conceptualised as the simple treatment of symptoms of problematic cultural tendencies.

When we understand culture as a whole way of life in Raymond Williams' sense (Williams, 1958), Robert constructs and evaluates two cultures of living/working through the labels 'unnatural' and 'balanced'. The unnatural way of life is conceptualised as not corresponding with human bodies, whereas a balanced lifestyle is described as an ideal state in which people live in harmony with nature and obtain the nutrients they need. Robert uses 'natural' as a rhetorical device to criticise contemporary cultural developments. In his understanding, nature and human beings/culture are related and mutually constituted, whereas technology frequently acts as a disruptive factor endangering the harmony of culture and nature. Robert would later explicitly stress that he is not criticising technology as such but is concerned about specific socio-technical configurations.

To achieve a balanced state, Robert considers collective agency central to triggering cultural change. In this sense, he recommends to 'lead children back, as indeed it is done in many schools, projects, kindergartens; to deliberately invest work and tell

them what a healthy diet is and what it involves and what is important' (282-4). The idea of 'leading children back' can be interpreted as a call for a reflection on historically grown cultural developments and their underlying values. Robert insists that he does not want to call for a reversal of scientific or technological progress to reconstruct a romantic ideal of 'back to nature'. Instead, he emphasises that explanatory work is needed to rethink current ways of living. He proposes an alternative trajectory for the future that demands an active and reflexive role of citizens, particularly of those who work with children as the representatives of future society.

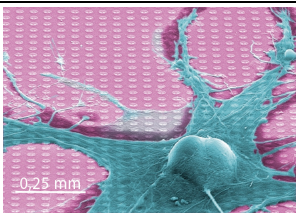
Rosa signals that she is grasping his vision but that she assesses it as unrealistic by referring to her work experience: 'Yes, I do understand what you mean, but I know from my experience and practice that we tried to get healthy food [...] but we didn't get it through' (291-3). Her assemblage thus emerges from a specific personal experience of unfulfilled expectations and challenges the more idealistic participants, whose ideas might not stand the reality test. What Rosa suggests is that in the 'real world' forces other than health concerns (e.g., financial considerations) are more powerful in framing decisions about nutrition and hence undermine efforts to change eating culture. In this sense, Rosa bluntly points at very important socio-political factors, such as limited resources in public administration, whereas Robert's argumentation builds on a culturally highly accepted but rather general ideal of the good life.

The episode on nano food, contrary to the nano socks episode, depicts a fairly emotional clash of two distinct discursive assemblages, which are grounded in fundamentally different understandings of food and both are sustained by a strong set of beliefs—be they experience- or value-based. Each assemblage shows considerable robustness, which is why we do not observe a full merging of these assemblages into a shared one.

Experimenting with assemblages – An episode about brain chip implants

Application Card #3

Neuro-electronic interfaces to the human brain



One vision of research into nanotechnology is to implant nano chips into the human brain. Medicine is thus hoping to control severe diseases such as Parkinson's.

Possible applications also aim at enhancing mental performance (e.g. at work or in sports) or, for military purposes, to control emotions such as fear or aggression.

The discussion of nanotechnology in the area of information and communication technology allowed us to identify a third way of how assemblages emerge in discourse: by collectively experimenting with different types of assemblages. In two groups, the majority of the participants chose the card 'Neuro-electronic interfaces to the human brain', which depicted both medical and enhancement scenarios (see *Application Card #3*). Whereas the vision of controlling diseases with a brain chip implant was viewed as a welcome application, the enhancement scenarios triggered a lively and at moments controversial debate. This finding indicates that the hybridisation of nature (in this case, the human body) and technology (chip implant) was not disput-

ed as such but that the nano brain chip only became an issue when it was used for other than purely medical goals.

The enhancement and control scenarios depicted on the card caused quite negative immediate reactions among the participants, who referred to them as 'strange' and 'scary' or as a 'horror vision'. These reactions express participants' 'instinct or gut feelings' (Banks et al., 2006) when confronted with morally laden scenarios. What followed in the debate can best be described as a process in which the group was trying to construct, rework, and experiment with different future-oriented assemblages to be able to develop a position on these technological options. Generally, these assemblages began with imagining a chip with a certain function and then reflecting what it would entail for the individual user or society at large. In the following, we shall take a closer look at the assemblages that emerged around two specific chip versions: a lexicon chip and a performance-enhancing chip.

The lexicon chip was conceptualised by the discussants as a technology that could provide an immediate knowledge gain, which some participants considered to be a quite desirable application for individuals:

Anna: Let's say if there's a chip available on the market costing one Euro [laughs], and with this chip everyone can memorise a whole encyclopaedia, including every small full stop and comma. Everybody would purchase it and get it implanted, wouldn't they? (734-8)

Anna here engages in a thought experiment based on the assumption that the chip is affordable for everyone and thus becomes a mass product. This precondition framed, to a large extent, the following debate and was hardly challenged—except by Benjamin, who twice argued that an enhancement chip would instead represent an expensive technology that would thus widen existing inequalities. The lexicon chip raised several issues that were explored in the construction of different assemblages.

First, participants reflected on whether such a chip scenario was actually feasible. In the course of the discussion, the human body was gradually identified as resisting easy modification and thus as limiting the realisation and stabilisation of such an assemblage. Then, on a much more fundamental level, the chip implant was also considered problematic because the brain was conceptualised as the place where one's identity and personality is located. Participants worried that 'the technological' might merge with one's personality and that actions triggered by the chip might become undistinguishable from one's own thoughts and actions. Thus, being able to uphold the distinction between 'the personal' and 'the technological' emerged as a central concern in the debate. Benjamin expresses this tension by juxtaposing two options:

Benjamin: If the brain is still able to make a distinction, well, this is now the lexicon hard disc and this is written in there, I don't like it, get rid of it; like when you really look up something in a book. I can read that all and I can then still ignore it. [...] Or if you are not able to make a distinction, it [the chip] becomes one with you so to speak. (905-13)

Benjamin is somewhat uncertain whether he should conceptualise the lexicon chip in analogy to a book, which he views as clearly external to the human mind, or as a device that merges with the body, thereby creating a mind-technology hybrid that leads to a loss of self-control. The issue of autonomy is further addressed when he starts questioning the objectivity of the lexicon chip's information and raises the issue of dependence. If a brain chip is implanted, he argues, we no longer acquire knowledge in a reflexive manner but 'the knowledge somebody else has written gets inserted. [...] If the chip is simply inserted, we become more dependent on the one who has written it' (884-6). This assemblage thus raises important ethical questions concerning autonomy and (in)dependence.

Although in the beginning access to the technology—the '1 Euro chip'—was viewed as central with regard to distributive justice, participants gradually began to anticipate that a wide distribution of such a chip would eventually standardise people's knowledge and threaten cultural diversity, as well as technological innovation in general. This sentiment was expressed in phrases such as 'will people be the same in the end' or 'streamlining all people', or by referring to a 'clone' scenario. However, other discussants seemed more positive, imagining the chip to hold the potential to trigger an increase in productivity and innovation as more energy could be devoted to creative thinking instead of mere information acquisition.

In a similar vein, the idea of a performance-enhancing chip was tested with regard to its compatibility with existing cultural practices and values. This testing was accomplished by comparing the chip to well-established modes of improving one's performance, which were conceptualised as an integral part of Western culture.

Benjamin: I mean this is already existing; a stupid example comes to my mind, concerning strengthening of stamina. I mean, everyone who is drinking a coffee in the morning; coffee is everywhere, it's actually nothing else than a sort of mini-doping. In the sense of: I'm tired now and I have to work in the morning and I better drink a coffee to be more productive. (831-7)

By referring to the act of drinking coffee—even if he calls it 'a stupid example'—Benjamin suggests that the chip might be consistent with current cultural practices. The group then discussed the effectiveness of coffee; thus, again, the feasibility of more permanent forms of enhancement appears as a central issue. Clara recalls a former schoolmate who used medication to enhance her performance during her studies, however, only occasionally, as permanent use was viewed as endangering health. In the course of this debate, the chip is gradually differentiated from these other means of enhancement, in particular with regard to its permanence in the body. This permanence is imagined to induce more fundamental socio-cultural change, and concern is expressed that the chip might act as a technology that contributes to furthering a performance-oriented culture—in this case, everybody would be obliged to have such a chip.

Later in the discussion, sport doping was introduced as another possible analogy (for more on the role of analogies in the discussion groups see Schwarz, 2014) to explore the consequences of such a brain enhancement chip. Participants stressed that doping was banned because it poses considerable harm to the human body, and enhancement technologies were placed into a similar framework in which health risks regulate societal uptake. At this point, Agnes, who at the beginning of the debate was rather enthusiastic about the possibility of a chip enhancement, appeared to change her position: 'If the body isn't built for it, then you shouldn't do it, because it's not healthy' (2051). This assemblage was, however, immediately reworked in the sense that if the chip would not induce negative health effects, nothing would speak against Olympics without any doping restrictions. In such moments, we observed a delegation of the decision to apply a technological innovation to the body—or to nature. 'If it works, why not' nicely summarises this position.

In a number of assemblages, other actors were called upon; for instance, the 'independent state' that was meant to act as a supervisory body, testing the chip similarly to the manner in which medication is tested. However, not unlike the discussion of the nano-bamboo socks, the competence of those responsible for governing technological innovations was doubted, which, in turn, contributed to a destabilisation of the assemblage.

To summarise, the debate about nano brain chips for enhancement can be described as continuous construction, testing and reworking of assemblages, in which both nature—in the form of the human body—and culture potentially threaten to counteract the realisation of the imagined technical scenarios. What is up for debate is how the chip might affect and contribute to changing individuals and, consequently, culture—especially to what extent it might present a threat to what is collectively valued, be it diversity of human beings or continuous technological, socio-cultural innovation. The assessment of the chip technology is thus largely dependent on the extent to which it is expected to put into question these shared values and orders; however, participants also spent considerable effort imagining assemblages in which such a new technology might have its place.

Discussion

In this paper, we explored how Austrian citizens assessed nanotechnologies in specific application areas, guided by the concept of discursive assemblages. We now briefly revisit the three empirical episodes in order to discuss how different versions of NCT were assembled, the negotiations involved and the underlying cultural orders in this process.

The first episode on nano-bamboo socks demonstrated that 'the natural' was viewed as a central category of orientation for consumer choice. The collective effort of purifying the hybrid nano-bamboo socks was guided by an understanding that re-drawing boundaries between 'the natural' and 'the technological' would allow participants to continue living with existing orders, such as their preference for 'the natural'. This explains why discussants felt uncomfortable with the fact that industrial players

could introduce such hybrids silently and unnoticed, thereby quietly contaminating 'the natural' and undermining consumers' agency. Although labelling appeared to be a solution, and represents a widely recognised way of handling complex technopolitical issues in the Austrian context (e.g., the GMO-free food label; Felt, 2015), there was limited trust in labels due to previous experiences. The episode demonstrated that the existing order, assumed to be shared, was simultaneously viewed as extremely fragile and under threat.

The episode concerning nano food was fundamentally different, as participants, right from the start, expressed divergent ideas about the very meaning of food and its relation to the body and society, which led to a clash of opposing assemblages. Whereas some constructed a 'natural way of life' as the ideal to strive for, others adhered to what was conceptualised as a more realisable version of the 'good life', namely a technology-supported one. In the former assemblage, 'the natural' emerged as a highly valued feature ascribed to certain—less or non-technologised—food products; in the latter, the non-disruption of entrenched socio-cultural orders (e.g., eating habits) was perceived as convenient in everyday practice, and technology was viewed as fixing any health-related drawbacks of this order. Both modes of ordering the (food-related) world through the use of different concepts of NCT proved, at least in this episode, quite robust.

The futuristic episode on the brain chip implant for enhancement demonstrated a third type of assemblage practice because participants were rather unsure about the brain chip's properties. Whereas the chip's use to address medical problems remained uncontested, its usage for physical or mental enhancement was highly challenged. Consequently, discussants continuously experimented with slightly varying assemblages to explore the issues such a new technology might generate in the future (e.g., feasibility, ethical, socio-cultural, health-related). Discussants struggled because the chip always seemed to resist easy categorisation along well-known lines. The creation of different assemblages thus resembled a process of testing; i.e., fathoming how a specific version would fit with value(d) orders in a particular cultural context, but also how nature—in form of the human body—could inhibit the realisation of enhancement scenarios.

As demonstrated, in the area of textiles and food, nanotechnology managed to reactivate established controversies, concerns, and positions. Although nutrition's potential for conflicting views in the group was actualised immediately because GM food was imagined as a predecessor to nano food, the group discussing the nano socks first had to explore the very meaning of this new hybrid artefact. However, in this instance as well, the group was able to tell a story of threatened orders by classifying the sock hybrid as another case in which natural textiles become technologised. On a discursive level, we suggest that a collective critique of outside actors or conditions, as in the socks case, depends on more or less shared assemblages and related values.

The usage of seemingly incompatible concepts of NCT in the episode on nano food triggered a much more inside-oriented controversy between the actors at the table. The challenge of the nano brain chip occurred at a somewhat different level. On the one hand, applying nano to solve health-related problems was viewed as largely unproblematic, which matches with Austrian experiences in other domains such as

genetics, in which agrobiotech is perceived to challenge 'the natural' as superior norm, whereas biomedical applications are largely accepted. In a similar way, nano for enhancement purposes was constructed as potentially problematic, which triggered the testing of varying assemblages, each of them co-emerging with several controversial socio-cultural issues.

Investigating the different discursive assemblages highlights the central role of nature as an ordering category with respect to assessing new technologies. Nature was invoked as a discursive resource in manifold ways (Schumann and Schwarz, 2015); for instance, as a powerful agent in guiding citizens' choices, a pure sphere to be saved (even at the price of considerably reducing its scope), an adjective describing a positive way of life or condition and hence an argument for certain choices. Technology, by contrast, appeared as a rather polarising agent. Although it was discussed as disturbing or even threatening nature and called into question because it destabilises valued socio-cultural orders, it was simultaneously imagined as a stabilising force that allows certain preferred cultural practices to remain unchanged.

The analysis, however, also demonstrates that talk about technologies is always talk about culture—especially about culturally dominant orders, values, and practices that are either viewed as productive and worth maintaining or else as problematic and thus in need of change. As analysts, this leads us to explore broader questions about what is regarded as negotiable in a cultural context and by whom and which orders, categories, or values are viewed as more stable and in need of protection, reinforcement, or adherence.

These questions are thus deeply connected to a specific technopolitical culture (Felt et al., 2010) because each assemblage also tells us how people conceptualise governance as well as how they view their place and spheres of influence. Explicit and tacit governance structures in technoscientific domains contain and adhere to orders of what is negotiable and what is taken for granted and assumed hardly changeable in particular cultural contexts. Although new technologies are often incorporated into global discourses and national policy papers tend to embrace them, it is essential to understand how diverse 'the local' actually is.

Against this background, we traced which governance assumptions were perceived to be predominant in the Austrian technopolitical context. Food and socks represent existing consumer products that were immediately connected to specific concerns, agendas, and governance approaches. Both lead to the questioning of existing governance strategies (labelling) and actors not fulfilling their assigned roles (the state as a mediating actor between consumers and industry). In contrast, the 'brain chip' case had less clear reference points, which first required the group to grasp the potential futures the chip might actuate and then to reflect whether these align with existing cultural values and orders. Issues of governance appeared, in this case, rather late in the debate and were not very clearly articulated. However, nature and culture were also conceptualised as governing agents; we observed instances in which nature, in the form of the body, was envisioned as refusing techno-cultural intervention, thus intervening in the regulation of technological innovations.

Conclusion

In conclusion, what can be learned from our study? First of all, it shows that the concept of discursive assemblages operates as a useful lens for recognising the non-fixed character of the discursive process, while still allowing the analyst to identify how specific elements, such as conceptions of nature, culture and technology, are (re)assembled at particular moments. In the analysis of three episodes selected from public engagement settings on nanotechnology, we encountered rather different ways of creating and negotiating assemblages: in the first episode, discussants collectively discuss a nature-technology hybrid (nano-bamboo socks) against the backdrop of a highly valued ideal of keeping 'the natural' and 'the technological' separate; the second episode exemplifies a clash of two assemblages as participants argued for or against the application of nanotechnology in food products; and the third example illustrates the process of collective experimentation with different assemblages to make sense of a highly futuristic nano chip for brain enhancement.

Besides this variety of assembling processes, all three episodes exemplify the underlying effort to maintain or re-establish specific modes of ordering when nanotechnological innovations threaten to blur boundaries and categories that are central in guiding people's everyday actions. Thus, the episodes illustrate how technological, natural and cultural orders are co-produced (Jasanoff, 2004) and mutually shape each other in multiple ordering and assembling practices. Accordingly, our approach of studying discursive assemblages in the making, their stabilisation and relation to other assemblages contributes to a better understanding of such a co-production on the level of language practices. Distinguishing nature from culture and technology is one crucial underlying rationale applied in this process.

Against this background, the policy move to semantically transform nanotechnology from a potentially threatening innovation into something 'natural' and thus quasi-unproblematic (see Austrian Nanotechnology Action Plan) might indeed function as a successful strategy because it rightly anticipates the cultural meaning that is attached to the concept of 'natural' (although matters are more complex, as the analysis reveals). Policy and other societal actors evidently share the civic epistemology that is at work in their technopolitical culture and they are eager to apply it; for instance, by differentiating the natural from the technological, to avoid polarisation and public debate, as was the case with GMOs.

However, with regard to another assumption about the public, common governance practices clearly miss the mark. Whereas policy-makers base their anticipations of public reactions towards emerging technologies on the unfounded assumption of a generally technophobic public, investigating citizens' discursive assemblages presents an empirically grounded way to understand how and based on which grounds technologies become (or are not) integrated into specific cultural contexts. Participants in public engagement settings never simply discuss or evaluate a technology as an isolated entity but always consider how it intersects with, supports, or disturbs existing socio-cultural values and orders. Interactive settings such as discussion groups provide a space to explore these processes collectively because participants are called upon to situate their own views and ideas in relation to other discus-

sants as well as with regard to (virtually present) societal actors from industry, science or politics.

Hence, following the flow of exchanges, struggles, and mutual support in group discussions around the formation and negotiation of assemblages enables the analyst to gain a fine-grained, bottom-up understanding of what types of orders people attend to, stabilise or modify when they encounter a new technology together. This understanding allows the identification of moments of clashing orders, moves towards convergence, attempts to impose one dominant order, or permits different orders to arise in peaceful coexistence, while being aware of the latent possibility for conflict.

An open controversy, as demonstrated in the food episode, can serve as a means to carve out and make plausible two different—even contradictory—sets of practices with regard to techno-scientific innovations, which both fit in with the broader sociocultural context. Hence, instead of fearing and trying to avoid a polarised debate, as suggested in the Austrian Nanotechnology Action Plan, we conceive of the creation of interactive public engagement settings valuable for enabling citizens' collective elaboration of the entire range of what it is that they care for and are attached to but also of what they may perceive as threatening on a personal or sociocultural level.

To detect the variety, complexity and contextual nature of public positions on emerging technologies, one must, however, refrain from the attempt to categorise citizens' engagement practices as clearly distinguishable acts of acceptance or rejection. By describing *how* people actually imagine living with emerging technologies, we have shown that citizens do not simply think or engage in a straightforward manner of making choices when encountering new technologies. We observed how citizens value new technologies in practice; i.e., how through creating different assemblages they could judge certain technological innovations as worth pursuing, dispensable or even threatening under specific conditions. They thus do not follow a binary logic of choice based on the managerial ideal of control and autonomous singular consumers. Rather, citizens negotiate and reformulate their positions and carefully ponder over potential consequences of possible future avenues. Citizens' positions are always as much about a specific technology as they are about the potential societal futures attached to it and whether or not these futures seem worth attaining.

Such processes follow a logic of care (Mol, 2008). Following such a logic of care implies nurturing and protecting spaces in which diverse forms of addressing sociotechnical innovation can occur, in which the constant work of rearticulating or blurring the boundaries of technology, nature and culture is acknowledged, and in which attention is drawn to the fact that we must consider the wider contexts of processes of sociotechnical innovation (Felt et al., 2013). Observing how people create and negotiate NCT assemblages and identifying zones of stability or (latent) conflict is one way of capturing these rich processes of care, which in turn should feed back into considerations about the governance of technosciences in contemporary democracies. Ultimately, such a detailed engagement highlights the importance of not simply classifying any questioning of technoscientific innovation as technophobia but, in an already technologised world, rather as an effort to produce, experiment with and evaluate alternative understandings of the public good.

Acknowledgements

First of all, we would like to thank the participants of the IMAGINE group discussions for their time and for sharing their ideas with us. We are especially grateful to our long-standing project colleague Michael Strassnig who significantly contributed to thinking and carrying out the research we present in this paper. Furthermore, this article benefited from generous feedback at a number of conferences and in particular from the critical reading of earlier versions by Bernadette Bensaude-Vincent. The feedback from the two reviewers and editors was most helpful in sharpening our argument. Finally, we would like to thank Gernot Rieder for his support in editing an earlier version of this paper.

Bibliography

- ANAP (2010) Austrian Nanotechnology Action Plan. Wien: Federal Ministry of Agriculture, Forestry, Environment and Water Management, http://www.nanoinitiative.at/1560_EN.pdf.
- Banks, S., Scully, J. L. & Shakespeare, T. (2006) Ordinary Ethics: Lay People's Deliberations on Social Sex Selection, *New Genetics and Society*, 25(3), 289-303.
- Bensaude-Vincent, B. (2004) Two Cultures of Nanotechnology?, *HYLE - International Journal for Philosophy of Chemistry*, 10(2), 65-82.
- Billig, M. (1987) *Arguing and Thinking: A Rhetorical Approach to Social Psychology*, (Cambridge: Cambridge University Press).
- Bowman, D. M. & Hodge, G. A. (2007) Nanotechnology and Public Interest Dialogue: Some International Observations, *Bulletin of Science, Technology & Society*, 27(2), 118-132.
- Burri, R. V. (2009) Coping with Uncertainty: Assessing Nanotechnologies in a Citizen Panel in Switzerland, *Public Understanding of Science*, 18(5), 498-511
- Cooren, F. (2010) *Action and Agency in Dialogue: Passion, Incarnation and Ventriloquism*, (Amsterdam/Philadelphia: John Benjamins Publishing Company).
- Davies, S., Macnaghten, P. & Kearnes, M. (eds.) (2009) *Reconfiguring Responsibility: Lessons for Public Policy (Part 1 of the Report on Deepening Debate on Nanotechnology)*, (Durham: Durham University).
- Davies, S. R. (2011) How We Talk when We Talk about Nano: The Future in Laypeople's Talk, *Futures*, 43(3), 317-326.
- Deleuze, G. & Guattari, F. (1988) *A Thousand Plateaus: Capitalism and Schizophrenia*, (London: Athlone Press).
- Delgado, A., Kjølberg, K. L. & Wickson, F. (2011) Public Engagement Coming of Age: From Theory to Practice in STS Encounters with Nanotechnology, *Public Understanding of Science*, 20(6), 826-845.
- Douglas, M. (1966) *Purity and Danger: An Analysis of the Concepts of Pollution and Taboo*, (London/New York: Routledge).
- Felt, U. (2015). Keeping Technologies Out: Sociotechnical Imaginaries and the Formation of Austrian Technopolitical Identity. In: Jasanoff, S. & Kim, S.-H. (eds.) *Dreamscapes of Mo-*

- ernity: *Sociotechnical Imaginaries and the Fabrication of Power*. (Chicago: Chicago University Press).
- Felt, U., Barben, D., Irwin, A., Joly, P.-B., Rip, A., Stirling, A. & Stöckelová, T. (2013) Science in Society: Caring for our Futures in Turbulent Times. *ESF Policy Briefing 50*. (Strasbourg: European Science Foundation).
- Felt, U., Fochler, M., Mager, A. & Winkler, P. (2008) Visions and Versions of Governing Biomedicine: Narratives on Power Structures, Decision-making and Public Participation in the Field of Biomedical Technology in the Austrian Context, *Social Studies of Science*, 38(2), 233-257.
- Felt, U., Fochler, M., Müller, A. & Strassnig, M. (2009) Unruly Ethics: On the Difficulties of a Bottom-up Approach to Ethics in the Field of Genomics, *Public Understanding of Science*, 18(3), 354-371.
- Felt, U., Fochler, M. & Winkler, P. (2010) Coming to Terms With Biomedical Technologies in Different Technopolitical Cultures: A Comparative Analysis of Focus Groups on Organ Transplantation and Genetic Testing in Austria, France, and the Netherlands, *Science, Technology & Human Values*, 35(4), 525-553.
- Felt, U., Schumann, S., Schwarz, C. G. & Strassnig, M. (2014) Technology of Imagination: A Card-based Public Engagement Method for Debating Emerging Technologies, *Qualitative Research*, 14(2), 233-251.
- Felt, U. & Wynne, B. (2007) Taking European Knowledge Society Seriously. *Report of the Expert Group on Science and Governance to the Science, Economy and Society*. European Commission.
- Fleck, L. (1979 [1935]) *Genesis and Development of a Scientific Fact*, (Chicago: University of Chicago Press).
- Haraway, D. (1991) *Simians, Cyborgs and Women: The Reinvention of Nature*, (New York: Routledge).
- Horlick-Jones, T., Walls, J. & Kitzinger, J. (2007) Bricolage in Action: Learning about, Making Sense of, and Discussing Issues about Genetically Modified Crops and Food, *Health, Risk & Society*, 9(1), 83-103.
- Horst, M. (2007) Public Expectations of Gene Therapy: Scientific Futures and Their Performative Effects on Scientific Citizenship, *Science, Technology & Human Values*, 32(2), 150-171.
- Irwin, A. (2006) The Politics of Talk: Coming to Terms with the 'New' Scientific Governance, *Social Studies of Science*, 36(2), 299-320.
- Irwin, A. & Michael, M. (2003) *Science, Social Theory and Public Knowledge*, (Maidenhead, Philadelphia: Open University Press).
- Jasanoff, S. (2004) *States of Knowledge: The Co-production of Science and Social Order*, (London; New York: Routledge).
- Jasanoff, S. (2005) *Designs on Nature: Science and Democracy in Europe and the United States*, (Princeton, N.J.: Princeton University Press).
- Jasanoff, S. & Kim, S.-H. (2009) Containing the Atom: Sociotechnical Imaginaries and Nuclear Power in the United States and South Korea, *Minerva*, 47119-146.
- Kearnes, M., Grove-White, R., Macnaghten, P., Wilsdon, J. & Wynne, B. (2006) From Bio to Nano? Learning Lessons from the UK Agricultural Biotechnology Controversy, *Science as Culture*, 15(4), 291-307.
- Latour, B. (1993) *We Have Never Been Modern*, (Cambridge, Mass.: Harvard University Press).
- Law, J. (ed.) (1991) *A Sociology of Monsters: Essays on Power, Technology and Domination*, (London/New York: Routledge).
- Law, J. (1994) *Organizing Modernity*, (Oxford: Blackwell).

- López, J. (2004) Bridging the Gaps: Science Fiction in Nanotechnology, *HYLE - International Journal for Philosophy of Chemistry*, 10(Special Issue on "Nanotech Challenges"), 129-152.
- Macnaghten, P. & Guivant, J. S. (2011) Converging Citizens? Nanotechnology and the Political Imaginary of Public Engagement in Brazil and the United Kingdom, *Public Understanding of Science*, 20(2), 207-220
- Michael, M. (2006) *Technoscience and Everyday Life: The Complex Simplicities of the Mundane*, (Maidenhead: Open University Press).
- Mol, A. (2008) *The Logic of Care: Health and the Problem of Patient Choice*, (London and New York: Routledge).
- Mol, A. (2010) Actor-Network Theory: Sensitive Terms and Enduring Tensions, *Kölner Zeitschrift für Soziologie und Sozialpsychologie*, 50(1), 253-269.
- Myers, G. (2004) *Matters of Opinion: Talking about Public Issues*, (Cambridge: Cambridge University Press).
- National Science and Technology Council (2000) National Nanotechnology Initiative: Leading to the Next Industrial Revolution, available at [http://www.whitehouse.gov/files/documents/ostp/NSTC Reports/NNI2000.pdf](http://www.whitehouse.gov/files/documents/ostp/NSTC%20Reports/NNI2000.pdf).
- Neill, J. O., Holland, A. & Light, A. (2008) *Environmental Values*, (London/New York: Routledge).
- Schumann, S. & Schwarz, C. G. (2015). Natürlich Nano. Die argumentative Kraft von Naturkonzepten in Laiendiskussionen zu Nanotechnologie. In: Compagna, D. (ed.) *Leben zwischen Natur und Kultur. Zur Neuaushandlung von Natur und Kultur in den Technik- und Lebenswissenschaften*. (Bielefeld: transcript).
- Schwarz, C. G. (2014) *Nano Is Like... The Role of Analogies in Public Engagement with Nanotechnology in Austria*. Thesis at the University of Vienna, Department of Science and Technology Studies.
- Wickson, F., Grieger, K. & Baun, A. (2010) Nature and Nanotechnology: Science, Ideology and Policy, *International Journal of Emerging Technologies and Society*, 8(1), 5-23.
- Williams, R. (1958) *Culture and Society 1780-1950*, (Harmondsworth: Penguin Books).
- Wilsdon, J. & Willis, R. (2004) *See-through Science: Why Public Engagement Needs to Move Upstream*, (London: Demos).

¹ Nanoscience and nanotechnology can very generally be defined as the study, manipulation, and building of materials measuring 1 to 100 nanometres, a scale at which many materials

² Governance refers to new constellations of power that go beyond the structures, rules and processes of classical government and thus to processes of more distributed and inclusive decision making and regulation.

³ This data stems from the FWF-funded research project 'Making Futures Present: On the Co-Production of Nano and Society in the Austrian Context' (P20890, PI: Ulrike Felt), running from October 2008 until September 2012 at the Department of Science and Technology Studies, University of Vienna.

⁴ <http://www.playdecide.eu/>, 07.12.2012

⁵ We use pseudonyms for the participants. *Mod* refers to the moderator. Numbers after the quotations relate to lines in the transcripts.